University of Colombo, Sri Lanka

University of Colombo School of Computing

DEGREE OF BACHELOR OF INFORMATION TECHNOLOGY (EXTERNAL)

Academic Year 2024 — 1st Year Examination — Semester 2

IT2306 — Database Systems

Multiple Choice Question Paper

(2 Hours)

Important Instructions

- The duration of the paper is **2 Hours**.
- The medium of instructions and questions is English.
- This paper has **40 questions** on **12 pages**. Answer **all** questions.
- All questions are of the **MCQ** (Multiple Choice Questions) type.
- Each question will have **5 (five)** choices with **ONLY ONE** correct answer.
- This paper consists of 100 marks and all the questions will carry equal marks.
- Answers should be marked on the **special answer sheet** provided.
- Note that questions appear on both sides of the paper. If a page or part of a page is not printed, please inform the supervisor/invigilator immediately.
- Mark the correct choices on the question paper first and then transfer them to the given answer sheet which will be machine marked. **Please completely read and follow the instructions given on the other side of the answer sheet before you shade your correct choices.**
- Any electronic device capable of storing and retrieving text, including electronic dictionaries, smartwatches, and mobile phones, is not allowed.
- Calculators are **not** allowed.
-

1) Which of the following is true about entity integrity constraints?

(a) The primary key value can be null.
(b) Every entity must have a unique identifier.
(c) A foreign key must be unique.
(d) Primary keys must allow duplicates.
(e) A composite key is a column that uniquely identifies a record.

2) Who is responsible for authorizing access to a database?

(a) Software Engineer	(b) Database Designer	(c) Data Analyst
(d) Data Administrator	(e) Database Administrator	

3) Which type of DML allows users to specify what data is needed rather than how to get it?

(a) Low-level DML	(b) Procedural DML	(c) Transactional DML
(d) Query Builder	(e) Non-Procedural DML	

4) What is the primary purpose of relational algebra in the context of databases?

(a) To format database reports
(b) To define mathematical operators for querying relational data
(c) To enforce referential integrity rules
(d) To store data in tabular file format
(e) To perform data encryption

5) Which of the following attributes is derived from other data?

(a) Name	(b) Gender	(c) Address
(d) Age	(e) Department	

6) The degree (or arity) of the following relation is

Flagship_Store(Store_ID (Primary Key), Department_Count, Exclusive_Item_Count)

(a) 0	(b) 1	(c) 2
(d) 3	(e) 4	

7) Which of the following SQL command syntax is utilised to define a foreign key with referential integrity that sets the child value to NULL when the parent is deleted?

(a) ON DELETE CASCADE	(b) ON DELETE RESTRICT
(c) ON DELETE NULL	(d) ON DELETE DEFAULT
(e) ON DELETE SET NULL	

8) What is the most appropriate reason to decompose a relation into multiple tables during normalization?

(a) To improve sorting performance and effectiveness
(b) To eliminate insertion, deletion, and update anomalies
(c) To ensure automatic indexing.
(d) To reduce memory consumption
(e) To allow unrestricted data access.

9) Which of the following statements is used to remove a table from the database?

(a) `DROP`	(b) `DETACH`	(c) `TRUNCATE`
(d) `REMOVE`	(e) `DELETE`	

10) Which of the following removes a user's access privileges in SQL?

(a) `DELETE`	(b) `DENY`	(c) `REVOKE`
(d) `REMOVE`	(e) `UNGRANT`	

11) From among the following, what does a System Catalog keep track of?

(i) Relationships between data in tables
(ii) Table Structures
(iii) Index Structures

(a) (i) only	(b) (ii) only	(c) (i) and (ii) only
(d) (ii) and (iii) only	(e) All (i), (ii) and (iii)	

12) The cardinality of domain D, where D is the Digits in the binary representation, is

(a) 0	(b) 1	(c) 2
(d) 4	(e) 8	

13) Which of the following is/are component/s of the relational model?

(i) Relational database objects
(ii) Relational operators
(iii) Relational constraints
(iv) Relational memory buffers

(a) (i), (ii) and (iv) only	(b) (i), (ii) and (iii) only	(c) (ii), (iii) and (iv) only
(d) All (i), (ii), (iii) and (iv)	(e) None of the above	

14) Which relational algebra operation is presented in the expression $R \bowtie_C S = \sigma_C(R \times S)$ and why is this identity useful?

(a) Natural join; filters based on schema-matching attributes.
(b) Intersection; uses cross-product for optimization.
(c) Division; simplifies attribute joins
(d) Outer join; ensures attribute type compatibility.
(e) Theta join; it decomposes join into primitive operations

15) Given an entity `Student(StudentID, Name)`, where `Email` is a multivalued attribute, what is the correct primary key for the resulting `Student_Email` relation in the relational model?

(a) StudentID	(b) Name	(c) StudentID, Name
(d) StudentID, Email	(e) StudentID, Email, Name	

16) Which of the following is an **incorrect** justification for creating a separate table to handle multivalued attributes?

(a) To preserve normalization rules, especially 1NF
(b) To eliminate redundancy caused by repeating groups
(c) To support many-to-many relationships between entities
(d) To allow flexibility in storing variable-length fields.
(e) To simplify indexing on atomic attributes

Consider the following online art gallery system scenario when answering questions from 17 to 21.

An online art gallery system tracks artists, their artworks, and exhibitions in which artworks are showcased.

- `Artist(artist_id, name, country, birth_year)`
- `Artwork(artwork_id, title, artist_id, medium, price)`
- `Exhibition(exhibition_id, artwork_id, exhibit_date, location)`

In the given database schema, the Artist table acts as a parent to the Artwork table, where each artwork is created by a specific artist, forming a one-to-many relationship.

Similarly, the Artwork table serves as a parent to the Exhibition table, as each artwork can appear in multiple exhibitions.

These relationships are enforced using foreign keys: Artwork.artist_id references Artist.artist_id, and Exhibition.artwork_id references Artwork.artwork_id.

17) Which of the following SQL statements **correctly** creates the **Exhibition** table including the exhibit date and location, while maintaining proper referential integrity?

(a)
```
CREATE TABLE Exhibition (
exhibition_id CHAR, artwork_id CHAR, exhibit_date DATE, location
VARCHAR(50), FOREIGN KEY(artwork_id) REFERENCES Artwork
);
```
(b)
```
CREATE TABLE Exhibition (
exhibition_id INT, artwork_id INT, exhibit_date DATE, location
VARCHAR(50), FOREIGN KEY(artwork_id) REFERENCES Artwork
);
```
(c)
```
CREATE TABLE Exhibition (
exhibition_id INT PRIMARY KEY, artwork_id INT, exhibit_date DATE,
location VARCHAR(50)
);
```
(d)
```
CREATE TABLE Exhibition (
exhibition_id INT PRIMARY KEY, artwork_id INT, exhibit_date DATE,
location VARCHAR(50), FOREIGN KEY (artwork_id) REFERENCES
Artwork(artwork_id)
);
```
(e)
```
CREATE TABLE Exhibition (
exhibition_id INT PRIMARY KEY, artwork_id INT, exhibit_date
DATE(8), location VARCHAR(50), FOREIGN KEY (artwork_id)
REFERENCES Artwork(artwork_id)
);
```

18) Which of the following will return the average price of **artworks** by each artist, listed from highest to lowest?

(a)
```
SELECT artist_id, AVG(price) FROM Artwork;
```
(b)
```
SELECT artist_id, AVG(price) FROM Artwork GROUP BY artist_id ORDER
BY AVG(price) DESC;
```
(c)
```
SELECT SUM(price)/COUNT(*) FROM Artwork GROUP BY artist_id ORDER
BY SUM(price)/COUNT(*) DESC;
```
(d)
```
SELECT artist_id, price FROM Artwork GROUP BY artist_id ORDER BY
price DESC;
```
(e)
```
SELECT artist_id, SUM(price)/COUNT(*) FROM Artwork GROUP BY
artist_id ORDER BY price DESC;
```

19) What is the error (if any) in the SQL statement given below, intended to change the size of the `price` column in the **Artwork** table from `DECIMAL(8, 2)` to `DECIMAL(10, 2)`?

```
ALTER TABLE Artwork MODIFY price DECIMAL(10, 2);
```

(a) `MODIFY` is not valid in standard SQL; use `ALTER COLUMN` instead

(b) `MODIFY` is not valid in standard SQL; use `ALTER TABLE COLUMN` instead

(c) `DECIMAL(10, 2)` cannot be used to change precision in-place

(d) The syntax is valid only if the column contains no data.

(e) There is no error in the SQL statement.

20) Which query given below returns only those artists who have created at least one artwork?

(a) `SELECT DISTINCT name FROM Artist;`

(b)
```
SELECT name FROM Artist LEFT OUTER JOIN Artwork ON
Artist.artist_id = Artwork.artist_id;
```

(c)
```
SELECT name FROM Artist RIGHT OUTER JOIN Artwork ON
Artist.artist_id = Artwork.artist_id;
```

(d)
```
SELECT name FROM Artist FULL OUTER JOIN Artwork ON
Artist.artist_id = Artwork.artist_id;
```

(e)
```
SELECT name FROM Artist JOIN Artwork ON Artist.artist_id =
Artwork.artist_id;
```

21) Which SQL statement gives only permission to update the `price` column in the **Artwork** table to user Amal?

(a) `GRANT UPDATE ON Artwork.price TO Amal;`

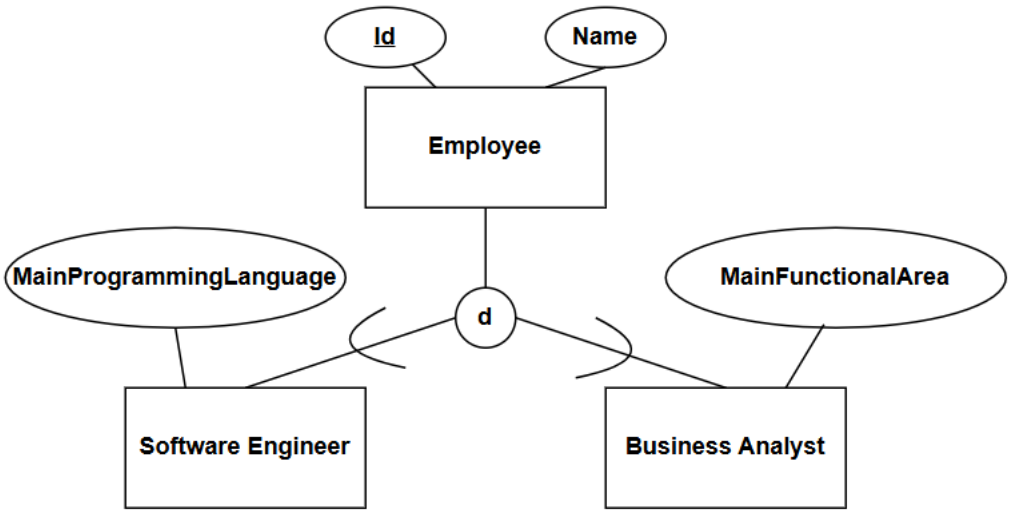
(b) `GRANT UPDATE price ON Artwork TO Amal;`

(c) `GRANT UPDATE(price) ON Artwork TO Amal;`

(d) `GRANT UPDATE COLUMN price ON Artwork TO Amal;`

(e) `GRANT UPDATE COLUMN(price) ON Artwork TO Amal;`

Consider the following Entity-Relationship Diagram when answering questions 22, 23 and 24.



22) What does the constraint represented in this diagram ensure about the relationship between the subclasses?

(a) An employee can have multiple sub-class roles at the same time.

(b) All employees must be in one of the subclasses.

(c) An employee can be either a Software Engineer or a Business Analyst, but not both.

(d) An employee must have both MainProgrammingLanguage and MainFunctionalArea.

(e) The same name cannot appear in both subclasses.

23) Which of the following would be the **most appropriate** relational schema for the given scenario?

(a) `Employee(Id PRIMARY KEY, Name, MainProgrammingLanguage, MainFunctionalArea)`
(b) `SoftwareEngineer(Id PRIMARY KEY, Name, MainProgrammingLanguage), BusinessAnalyst(Id PRIMARY KEY, Name, MainFunctionalArea)`
(c) `Employee(Id PRIMARY KEY, Name), SoftwareEngineer(Id PRIMARY KEY, MainProgrammingLanguage, FOREIGN KEY(Id) REFERENCES Employee(Id)), BusinessAnalyst(Id PRIMARY KEY, MainFunctionalArea, FOREIGN KEY(Id) REFERENCES Employee(Id))`
(d) `Employee(Id PRIMARY KEY, Name, Role, Skill)`
(e) `Employee(Id PRIMARY KEY, Name), Role(Id, RoleType, Skill)`

24) In the given scenario, if we try to apply the "one table per subclass" strategy with no superclass table, what specialization constraint is implicitly enforced?

(a) Overlapping and Partial	(b) Disjoint and Partial	(c) Disjoint and Total
(d) Overlapping and Total	(e) Multivalued and Derived	

Consider the following relation when answering questions 25, 26 and 27.

Consider the relation Borrow(BookID, Title, MemberID, MemberName, BorrowDate, ReturnDate) with functional dependencies: (Assume {BookID, MemberID} is the only candidate key)

BookID → Title
MemberID → MemberName
{BookID, MemberID} → BorrowDate, ReturnDate

25) Assuming the above relation is not decomposed, which of the following anomalies are guaranteed to occur?

(i) Update anomaly, because changing a book title or member name must be done in multiple rows.
(ii) Insert anomaly, because new books or members cannot be added unless a borrow occurs.
(iii) Delete anomaly, because deleting a borrow record may lose book or member information.

(a) (i) only	(b) (ii) only	(c) (iii) only
(d) Only (i) and (ii)	(e) All (i), (ii) and (iii)	

26) Why is this relation not in the Second Normal Form (2NF)?

(a) MemberID → MemberName is a transitive dependency.
(b) BookID → Title is a partial dependency, violating 2NF.
(c) {BookID, MemberID} → BorrowDate is not a full dependency.
(d) MemberName is not functionally dependent on any key, so 2NF is violated.
(e) Not due to any of the above

27) What is a correct minimal decomposition to eliminate all anomalies while preserving dependencies and lossless join?

(a) R1(BookID, Title)
R2(MemberID, MemberName)
R3(BookID, MemberID, BorrowDate, ReturnDate)

(b) R1(BookID, MemberID, ReturnDate)
R2(MemberID, MemberName)
R3(BookID, Title, BorrowDate)

(c) R1(BookID, BorrowDate)
R2(MemberID, MemberName)
R3(Title, ReturnDate)

(d) R1(BookID, Title)
R2(MemberName, ReturnDate)
R3(MemberID, BookID, BorrowDate)

(e) R1(BookID, Title, MemberID)
R2(MemberID, MemberName)
R3(BookID, BorrowDate, ReturnDate)

28) Which SQL query correctly deletes all orders placed before 2021-01-01?

(a) `DELETE FROM orders WHERE order_date < '2021-01-01';`
(b) `DROP orders WHERE order_date < '2021-01-01';`
(c) `REMOVE FROM orders WHERE order_date < '2021-01-01';`
(d) `DELETE * FROM orders WHERE order_date < '2021-01-01';`
(e) `DELETE * FROM orders WHERE order_date < 2021-01-01;`

Consider the below relations associated with Veterinary Clinic Management when answering questions 29 and 30.

`Pet(pet_id, pname, species, age, owner_id)`

`Owner(owner_id, name, phone)`

`Visit(pet_id, visit_date, vet_id, reason)`

`Vet(vet_id, vname, specialization)`

29) Which of the following expressions retrieves the names of owners whose cat has visited a vet specialized in Dermatology?

(i) $\Pi_{name}((\sigma_{species='cat'}(Pet) \bowtie Visit) \bowtie \sigma_{specialization='Dermatology'}(Vet) \bowtie Owner)$

(ii) $\Pi_{name}((\sigma_{specialization='Dermatology'}(Vet) \bowtie Visit) \bowtie \sigma_{species='cat'}(Pet) \bowtie Owner)$

(iii) $\Pi_{name}((Pet \bowtie \sigma_{specialization='Dermatology'}(Vet) \bowtie Visit) \bowtie Owner)$

(a) (i) only	(b) (ii) only	(c) (i) and (ii) only
(d) (ii) and (iii) only	(e) All are correct	

30) What is the most suitable expression to find the names of pet owners whose pet has never visited a vet with the specialization 'Surgery'?

(a) $\Pi_{name}((Owner \bowtie Pet) - ((Pet \bowtie Visit \bowtie \sigma_{specialization='Surgery'}(Vet)) \bowtie Owner))$

(b) $\Pi_{name}((Owner \bowtie Pet) \cap (\sigma_{specialization \neq 'Surgery'} Vet \bowtie Visit))$

(c) $\Pi_{name}((\sigma_{specialization \neq 'Surgery'}(Vet) \bowtie Visit) \bowtie Pet \bowtie Owner)$

(d) $\Pi_{name}(\sigma_{specialization='Surgery'}(Vet \bowtie Visit \bowtie Pet \bowtie Owner))$

(e) $\Pi_{name}(Owner) - \Pi_{name}((\sigma_{specialization='Surgery'}(Vet) \bowtie Visit \bowtie Pet) \bowtie Owner)$

31) Which of the following best describes the role of polyinstantiation in multilevel security databases?

(a) Prevents users from inserting duplicate keys into base tables

(b) Allows multiple users to simultaneously update the same record

(c) Ensures referential integrity is preserved across all user views

(d) Enables storing multiple records with the same key at different classification levels to prevent unauthorized inference

(e) Grants automatic SELECT permissions to all users regardless of access level

32) Which characteristic allows users to derive new attributes like "age" from "DOB" (Date of Birth)?

(a) Physical Data Independence

(b) Logical Data Independence

(c) External Level Customization

(d) Physical Data Manipulation

(e) Internal Level Mapping

33) Which of the following best describes the case when a decomposition is dependency-preserving but not lossless?

(a) It allows the original relation to be perfectly reconstructed.

(b) It can only happen if candidate keys are composite.

(c) It is not allowed in any normal form.

(d) It satisfies 2NF but not BCNF.

(e) It retains all original functional dependencies but may generate spurious tuples.

34) Consider the following SQL statements.

Step 1: Create the Product Table and Inserting Data

```
CREATE TABLE Product(
productID VARCHAR(10) PRIMARY KEY, productName VARCHAR(50) NOT NULL,
price DECIMAL(10,2) NOT NULL, category VARCHAR(20) NOT NULL
);

INSERT INTO Product (productID, productName, price, category)
VALUES ('P101', 'Smartphone', 1200, 'Electronics');
```

Step 2: Creating Views

```
CREATE VIEW MidRangeProduct AS
SELECT * FROM Product WHERE price > 900;

CREATE VIEW HighEndProduct AS
SELECT * FROM MidRangeProduct WHERE price > 1000
WITH CHECK OPTION;
```

As Step 3, if we try to execute one of the following SQL statements, which one will execute **successfully**?

(a)
```
UPDATE HighEndProduct SET price = 950
WHERE productID = 'P101';
```
(b)
```
UPDATE HighEndProduct SET price = 1000
WHERE productID = P101;
```
(c)
```
UPDATE MidRangeProduct SET price = 1000
WHERE productID = P101;
```
(d)
```
UPDATE MidRangeProduct SET price = 1000
WHERE productID = 'P101';
```
(e) None of the above

35) Which of the following operations **cannot** be included as a primitive in a minimal complete set of relational algebra operations?

(a) A binary operation that filters rows based on a boolean predicate
(b) An operation that vertically partitions a relation
(c) An operation that pairs every tuple in one relation with every tuple in another
(d) An operation that outputs all tuples found in both operand relations
(e) An operation that subtracts one relation from another

36) Consider the below relations where primary keys are underlined.

- `Students(StudentID, Name)`
- `Courses(CourseID, Title)`
- `Enrollments(StudentID, CourseID, Grade)`

Enrollments.StudentID and Enrollments.CourseID are foreign keys referencing Students.StudentID and Courses.CourseID.

Which of the following best ensures that no enrollment exists for a non-existent student or course?

(i) Adding NOT NULL constraints to Enrollments

(ii) Using CHECK constraints on Enrollments

(ii) Enforcing foreign key constraints in Students and Courses relations

(a) (i) only	(b) (i) and (ii) only	(c) (ii) and (iii) only
(d) All (i), (ii) and (iii)	(e) None of the above	

37) Consider the following Scenarios.

Scenario 1: A company policy states that every employee must be hired as either a manager or an engineer, and cannot serve both roles.

Scenario 2: In a university, every person is either a student, an employee, or both.

Scenario 3: In an e-commerce platform, a user may choose to only browse, without buying or selling. Or they could do both.

Scenario 4: An organization only tracks additional info for cars and motorcycles — not all vehicles need subclass data, and each vehicle is one type only.

Which of the following **correctly** states the order of constraints on the above scenarios if they were translated to an ER model?

(a) Overlapping - Total Specialization, Overlapping - Partial Specialization, Disjoint - Partial Specialization, Disjoint - Total Specialization

(b) Disjoint - Total Specialization, Overlapping - Total Specialization, Overlapping - Partial Specialization, Disjoint - Partial Specialization

(c) Disjoint - Total Specialization, Overlapping - Partial Specialization, Disjoint - Partial Specialization, Overlapping - Total Specialization

(d) Disjoint - Total Specialization, Disjoint - Partial Specialization, Overlapping - Total Specialization, Overlapping - Partial Specialization

(e) Overlapping - Partial Specialization, Overlapping - Total Specialization, Disjoint - Total Specialization, Disjoint - Partial Specialization

38) In an Entity-Relationship (ER) model, which of the following is the correct way to convert the below scenario into a structure suitable for a relational database?

A hospital database needs to track prescriptions by recording the doctor who prescribed, the medication in the prescription, the relevant patient, the date and dosage.

(a) Create a direct link between Doctor and Medication, and store patient information as an attribute.
(b) Create three separate binary relationships: Doctor–Medication, Doctor–Patient, and Patient–Medication.
(c) Introduce a new associative entity that includes foreign keys to Doctor, Patient, and Medication tables, along with attributes for date and dosage.
(d) Merge Doctor, Patient, and Medication data into one large table that includes all relevant attributes.
(e) Use separate Doctor, Patient, and Medication tables, and represent the relationship using a set of views instead of a dedicated table.

39) Which clause is evaluated after GROUP BY but before ORDER BY in SQL's logical query processing order?

(a) `SELECT`	(b) `WHERE`	(c) `FROM`
(d) `HAVING`	(e) `LIMIT`	

40) What happens if a multi-row INSERT INTO … SELECT … targets a table with a UNIQUE constraint and some values violate it?

(a) All valid rows are inserted.	(b) Only the first valid row is inserted.
(c) Conflicting rows are updated.	(d) A rollback is issued for each invalid row.
(e) The entire insert fails	

THE END